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Land & Water
Conserving Natural Resources in Illinois
University of Illinois at Urbana-Champaign, College of Agriculture, Cooperative Extension Service

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What Price Conservation?

The Economics of Soil Conservation

Graphic by Paula Wheeler/Illinois Research

The Soil's Future

"My interest is in the future because I'm going to spend the rest of my life there," said American inventor Charles Franklin Kettering.

When it comes to considering soil conservation and economics, the future becomes a critical consideration because, like Kettering, you will be spending the rest of your life there. However, any glimpse at the future raises a host of questions:

If my land continues to erode at its present rate, what will it cost me in topsoil? What will it cost in yields? And what will it cost to do something about the erosion on my land?

When tackling these problems, you must recognize that society, in general, needs to balance four major goals: (**1**) preserve soil productivity for future generations; (**2**) provide an adequate supply of food at a reasonable cost for human use; (**3**) provide adequate economic returns to producers; and (**4**) protect water quality.

To help maintain the soil's natural productivity, soil experts say that erosion must be brought within the soil-loss tolerance level, also known as the "T value." When erosion exceeds the T value, soil is being lost so fast that its natural productivity is being diminished. The T value depends on the soil type, but for most Illinois soils it ranges from 1 to 5 tons of soil loss per acre per year.

The major objective of the Illinois erosion-control program is to bring all farmland in the state within the tolerance level by the year 2000. But once again, doing so raises some complicated questions. Is it economically realistic to expect all farmers to meet the T value? And if so, what is the most economical strategy for an individual farmer to meet T?

Stewardship And Profits

A number of underlying motives guide a farmer's decisions. Not the least of these motives may be the desire to be a good steward of the land; to preserve the soil for future generations.

However, it is difficult to measure such a subjective goal. A more easily measured goal is that of maximizing profits, or net income. Far from being inherently sinister or corrupt, this goal is the same one that prompts most investors or savers to place their funds where returns will be highest.

According to one line of reasoning, farmers who emphasize maximizing profits over other possible goals are more likely to predominate because they will have the money to buy and control farmland. But, of course, that still does not justify maximizing profits when it means the permanent destruction of our soil resource.

The ideal solution would be one in which farmers could control erosion and maximize profits at the same time. Some people believe that the increasingly popular practice of conservation tillage does just that.

Conservation tillage is a system that leaves crop residue on the ground to protect the soil from raindrops and runoff; and it has gained a reputation for saving soil, oil, and toil. To find out whether this reputation is deserved, a closer examination is needed. We need to look at how the various tillage alternatives affect erosion, costs, and yields.

Tillage And Erosion

In terms of reducing erosion, the most effective tillage choice is no-till, a form of conservation tillage that disturbs very little soil and leaves essentially all crop residue on the soil surface. According to research, a switch to no-till can reduce erosion by 70 to 95 percent, depending on the amount of crop residue left on the ground.

At the other end of the spectrum is tillage with the moldboard plow, which loosens the soil, buries virtually all plant residue and can lead to the loss of an enormous amount of soil on sloping land.

Hillard Morris, an Effingham County farmer and former president of the Illinois Association of Soil and Water Conservation Districts, uses bushel baskets and a truck to illustrate the impact of soil erosion.

The truck holds 12 tons of soil, which equals the amount of soil that is eroding annually on every acre in Illinois with an erosion problem. Also, on those acres with an erosion problem, an average of two bushel baskets of soil are lost for every bushel of corn produced.

Land is considered to have an erosion problem when erosion exceeds the soil-loss tolerance level, or "T" value. When erosion exceeds the T value, soil is being lost so fast that the land's natural productivity is diminished.

Reduced tillage — which typically involves using either a chisel plow or disk — offers a compromise between no-till and the moldboard plow. Such a system buries some residue, so it doesn't control erosion as effectively as no-till; but it does a better job than the moldboard plow.

One problem, however, is that some farmers shift to a chisel plow and/or disk and then make so many secondary tillage passes over the field that the soil is smoothed out and most of the residue is buried during the critical period — between planting and development of the crop canopy.

Tillage And Costs

One way to compare the profits from moldboard, no-till, and reduced tillage systems is to simply compare the costs for performing the various tillage operations — plowing and disking, for example. Here are some factors to consider:

— Because no-till and reduced tillage require fewer trips over the field than conventional tillage, labor costs are reduced.

— Fewer tillage passes mean a significant fuel savings. According to University of Illinois estimates, the moldboard system requires 7.75 gallons of fuel per acre; the chisel plow, 7.05 gallons per acre; the disk, 5.35 gallons per acre; and no-till, only 2.50 gallons per acre.

— Conservation tillage may require special equipment. If you do not have such equipment, you may face the added cost of purchasing new machinery.

— No-till requires fewer implements than conventional tillage, and the power units can be smaller and possibly fewer in number. Therefore, if you actually do switch to fewer implements and smaller power units, the total no-till machinery investment will be less than that for conventional or reduced tillage.

— With conservation tillage, you may have an increased expense for additional pesticides. The soil-saving crop residue cover, which conservation tillage leaves on the ground, may increase the pressure from weeds and insects. Therefore, you may have to increase pesticide application rates or the number of applications.

— Fertilizers may be more costly with no-till, depending on the type of material used and the method of application.

As you examine the pros and cons of conservation tillage, you also should take into consideration the economic benefits that pertain to all soil-saving practices — not just to conservation tillage.

For example, eroded soils cost more to farm than non-eroded soils. An Iowa study showed that as soil became more eroded, it generally took more fuel to till the land. The reason? As the topsoil eroded away, it became necessary to plow the lower layers of soil. The subsoil is more difficult to turn over and requires more fuel and time to till. Therefore, if you use practices that save the soil, you will avoid the problem of increased fuel expenses.

The Iowa study — which was made on deep loess soils — also showed that the soil required an annual addition of 10 pounds of nitrogen per acre to maintain yields when erosion went from slight to moderate. When erosion went from moderate to severe, an extra 30 pounds were required per acre annually. Once again, farm operators who use practices that control erosion would not bear this cost in the future.

Tillage And Yields

Studies at the U of I and other experiment stations have indicated that continuous corn yields tend to be slightly lower for no-till than for conventional tillage on dark-colored, poorly drained, level soils. However, there is very little, if any, yield reduction when a corn-soybean rotation is used.

The effect of both tillage and soil type on average yields is depicted in a table developed at Purdue University. (See Table 1.) All of the figures in the table compare the yields from different tillage systems on different soil types. For example, a fall chisel system in continuous corn will produce 3 percent less yield than the fall moldboard system if the soil is dark, level, and poorly drained. However, if the soil is light-colored and level, the chisel plow will *increase* yields by 2 percent over the fall moldboard plow.

In addition, keep in mind that the major erosion problems are not on this level, poorly drained land. Most erosion occurs on well-drained, sloping soils where no-till works best. According to Table 1, no-till continuous corn on light-colored, sloping land will produce 10 percent greater yields than the fall moldboard plow system in continuous corn.

If you have a mixture of sloping and level land on the same field, you need to evaluate how alternative tillage practices would affect the field or farm overall.

Another way that conservation tillage can affect yields is by the potential increase in weed and insect problems. Generally, though, with refinements being made in tillage equipment and pesticides, farmers should be able to master a conservation tillage system on most soils without losing yields to insects and weeds.

Putting together the three considerations — erosion, costs, and yields — conservation tillage comes out looking good when used on appropriate soils. It is significantly more effective in controlling erosion than conventional tillage, and its costs are generally no more or less than with a moldboard plow system. As for yields, they are generally equal to or higher on well-drained, sloping soils.

Table 1. Effects of tillage on corn and soybean yields with six tillage systems and three Indiana soil groups.

	Soil Drainage Group		
	Dark, level, poorly drained, 0-2% slope	Light, nearly level, somewhat poorly drained, 0-2% slope	Light, sloping, well-drained, 3% slope and over
Continuous Corn			
Fall moldboard	0	0	0
Fall chisel	−3	+2	+5
Spring moldboard	−7	0	+5
Spring disk	−5	0	+5
Ridge tillage	0	+2	+10
No-till	−10	−5	+10
Rotation Corn			
Fall moldboard	+7	+7	+7
Fall chisel	+7	+7	+13
Spring moldboard	0	+7	+13
Spring disk	+7	+7	+13
Ridge tillage	+7	+7	+18
No-till	+5	+7	+18
Rotation Soybeans			
Fall moldboard	0	0	0
Fall chisel	0	0	+5
Spring moldboard	−10	0	+5
Spring disk	−5	0	+5
Ridge tillage	0	0	+10
No-till	−10	−5	+10

This table shows how different tillage systems and rotations on different soil types will affect yields.

For example, on light soil with a 3 percent slope, fall chiseling in continuous corn is given the figure of "+5", while the fall moldboard plow in continuous corn is given the figure of "0". This means that the fall chisel plow system will produce 5 percent *greater* yield when compared with the moldboard plow system.

Meanwhile, on dark, poorly drained soil with a 0 to 2 percent slope, fall chiseling in continuous corn has a "yield factor" of −3, while the fall moldboard plow once again has a yield factor of 0. This means that the fall chisel plow will produce 3 percent *less* yield than the moldboard plow on dark, poorly drained soil.

In using the table, it is possible to compare the yield factors listed for continuous corn with those for rotation corn. But it is *not* accurate to compare the yield factors listed beneath one soil type with those under another soil type.

Contouring

On certain soils, conservation tillage alone may not be adequate for erosion-control, so a combination of conservation practices may be required. For example, another relatively inexpensive way to help control erosion on some fields is with contouring, the practice of doing all tillage and planting across the slope. Because contour channels run across the slope, they help prevent runoff from flowing directly downhill and gaining sufficient velocity to cause erosion.

Contouring takes a little more time than straight row cultivation, but it is a low-cost and effective way to control erosion. On gentle slopes of 2 to 7 percent, contour farming can cut erosion in half.

Hay And Pasture

Over the last eight to 10 years, national farm policy has stimulated intensive row cropping on erosion-prone lands that previously had been left uncultivated or used for forage and cover crops.

Unfortunately, less intensive crop rotations is precisely what is needed to protect much of our land from damaging erosion. Some of the land that currently has the worst erosion problems may even need to be converted to *permanent* cover. It has been estimated that 900,000 acres in Illinois fall in that category.

Generally, hay and pasture provide lower economic returns than grain crops. But on highly erosive acres where permanent cover is needed, hay and pasture are competitive with grain crops.

Terraces And Other Structures

Looking back on his first impression of a new piece of land, a certain farmer observed, "You could have hidden a pickup in some of the gullies when we came here."

Land such as this may require more than a change in tillage to bring severe, gully-slicing erosion under control. Sometimes, it may need soil conservation structures, such as terraces and grassed waterways.

Terraces are earth embankments, channels, or combinations of embankments and channels that control water movement. They essentially reduce erosion by shortening the length of a slope or by redirecting and stopping runoff water. The shorter the slope, the less chance water has for gaining enough velocity to cause excessive erosion.

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Terraces are most likely to be economical on moderately sloping (4 to 8 percent), highly productive land that is clearly being gouged by high rates of erosion — rates that may even exceed 30 tons of soil loss per acre per year.

Money Now Or Money Later?

An obstacle to adopting a conservation practice such as terraces may be that the investment costs are not recovered in the short run. Because future returns are worth less than the same amount of money today, a distant payoff may reduce a farmer's economic incentive for investing in a soil conservation practice.

What's more, even if the conservation practice *does* pay off in the short run, there is another obstacle: A farmer may find an alternative investment that provides an even greater return. (It should be noted that these obstacles apply to any investment, not just conservation practices.)

In situations like these, a farmer may need to consider more than how the conservation practice will affect his net income. For example, even if he knows of an investment that will return more money than an investment in saving soil, the added satisfaction of improving the environment and soil productivity may sway his choice toward conservation.

In the case of a delayed soil conservation payoff, the soil-saving practice may still provide an economic incentive in the form of tax benefits for high-income farmers or landowners. High-income landowners can use practices such as terraces as a shelter to reduce income taxes in the short run and increase the land's value in the long run.

Also, a delayed payoff may need to be put into perspective. A payoff that does not come for 20 years, for instance, is only a generation away. A farmer's children may be farming the land at that time; and even if they are not, they will be part of a society that depends on well-protected land.

'The Technology Fix'

Thomas Robert Malthus, an English economist living in the late 1700s, was one of the first people to present the overpopulation theory, which states that population growth tends to increase faster than food production. He predicted that the increasing population would become so great in the 1800s that the world would not be able to support itself and calamaties would result.

But Malthus' prediction failed to materialize in the 1800s because he and others underestimated the rate at which technology increased food production and kept up with the increasing population.

This is one of the most striking examples of the importance of considering technological improvements when trying to look into the future — and this includes any attempts to estimate the effect of erosion on the cost and supply of future food production.

Technology influences production in two basic ways. First, it can affect it *directly* when a new discovery increases yields. An obvious example of this is the development of hybrid corn in the 1930s — an innovation that greatly increased yields.

However, technology also can have an *indirect* influence. In the 1960s, for instance, farmers began applying larger amounts of nitrogen fertilizer and yields increased. In this case, it was the technological development of anhydrous ammonia that reduced the cost of nitrogen fertilizer and made it economically possible to increase the rate of application.

Although technology has overcome some large obstacles to keep yields increasing, in the process it may have created a dependence on the part of some farmers. This dependence has been called a "technological fix."

In other words, some people have become so dependent on technology that they use it as an excuse for abusing the land. "Why worry about soil conservation?" some say. "The crop yields on my land have doubled over the past 30 years. . . . Surely, we'll make more progress in the future."

There are several flaws with this philosophy. First, technology may not have the solution to all of the problems we create. And second, we should ask ourselves, "Although technology has kept yields increasing, couldn't yields have been even *higher* if the land had been protected?" Studies in the Palouse area of the Northwest have shown that as the soil was more eroded, the yield gains due to technological improvements were less.

Costs To Society

So far, the focus has been on the costs and gains of soil conservation for the individual farmer. However, the conservation issue affects the entire society for two basic reasons.

First, as discussed earlier, the management of soil will undoubtedly have some bearing on future generations. Do farmers, by exploiting soil resources today, have a right to burden future generations with a scarce and, therefore, expensive food supply? On the other hand, does society have a right to expect farmers and resource owners to foot the conservation bill and still provide an inexpensive and plentiful food supply? This is a classic dilemma for all scarce, depletable resources, not just for farmland.

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The second major reason for society's concern with soil erosion is that sediment from farmland damages rivers, lakes, streams, and other areas such as road ditches. Most lakes naturally fill with sediment, but soil washing from agricultural land has accelerated this process to the point that some lakes are expected to completely choke with sediment hundreds of years before they naturally would.

Society receives a tangible bill for sedimentation in the cost for dredging and for finding new sources of water, and it pays an intangible cost by having to tolerate a damaged environment.

Another problem is that certain chemicals and nutrients can attach to soil particles and hitch rides into the water system. This can be a particular problem after heavy rainfalls, when fish kills are most often reported.

These off-site damages often continue unabated because the farmer does not have to bear the costs associated with them. Also, because the source of pollution is so diffuse, it is difficult to identify the offending fields and the amount of pollutants contributing to the problem. In other industries in which the pollution source is easier to pinpoint — such as a drainpipe from a factory, for example — the state has the power to impose regulations, fines, and plant closings.

Although agricultural sources of water pollution are more difficult to regulate, these problems were still addressed during the 1970s in section 208 of the Clean Water Act. This legislation has required states to formulate plans to reduce erosion-related water pollution.

So far, the Illinois conservation policy has emphasized voluntary programs that appeal primarily to a farmer's self-interest, often in the form of grants and cost-sharing of conservation investments. But this approach is costly, may have only a temporary effect, and leaves in doubt the future availability of funding.

If the voluntary approach does not appear to be working, nonvoluntary approaches may eventually be necessary.

The tension between private and public concern about soil erosion has been clearly shown in a U of I study during the early and mid-1970s. The study found that farmers who take a "private view" of erosion (they only consider how erosion affects themselves), have an immediate incentive to control erosion with only certain conservation practices. To those who follow a "societal view" (they consider how erosion affects neighbors and society as a whole), almost *all* conservation practices were found to provide an immediate payoff for controlling erosion.

The study concluded, therefore, that to achieve conservation goals, society may have to create more short-term economic incentives for farmers who maintain a private view; or else these farmers must develop a conservation ethic, in which they have a firm commitment to saving soil, even if it costs something in the short run.

Conclusions

After all is said and done, is it really possible to maintain production and still conserve soil? Or are production and conservation "two mules pulling in opposite directions?"

The answer for a particular piece of land depends on so many factors that conclusions will vary from farmer to farmer. The encouraging note is that as more farmers take conservation seriously and refine soil-saving techniques, they are finding that many conservation practices do not cost more, even in the short run. And in the long run, the economics favor soil conservation even more clearly.

Without proper management of land, erosion has the perverse tendency to remove soil from the poorest section of the field and carry it to areas where topsoil already is adequate. Soil usually erodes from slopes, which cannot afford to lose soil, and washes down to level areas where the layer of valuable topsoil is thicker.

In other words, erosion steals from the poor land and gives to the rich. In anyone's book, that is poor economics.

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